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MECHANICS OF ENGINEERING.

The Mechanics of Engineering. By Prof. A. Jay DuBois, C.E., Ph.D., Yale University. Vol. i., Kinematics, Statics, Kinetics, Statics of Rigid Bodies and of Elastic Solids. Pp. xxxiv + 634. Price 31*s.* 6*d.* Vol. ii. Stresses in Framed Structures and Designing. Pp. xxiii + 609. Price £2 2*s.* (New York: Wiley and Sons; London: Chapman and Hall, Ltd., 1902.)

THIS manual forms one of a number of publications which are being prepared by professors and instructors of Yale University and issued in connection with the Bicentennial Anniversary.

Dealing first with vol. i., the first 400 pages of the book, about two-thirds of the whole, are devoted to what may be considered as the preliminary work of developing the principles of the mechanics of solids. In substance this part corresponds with the author's treatise on the "Elementary Principles of Mechanics," published in three volumes, entitled "Kinematics," "Statics" and "Kinetics." The treatment is mainly analytical, graphical methods being reserved for the later chapters, in which the practical application of the principles is dealt with, and for the second volume.

In the section dealing with the fundamental and derived units of measurement, the author rightly insists on the importance of constantly keeping in mind the dimensions of the various quantities, and of checking equations from time to time by inserting the dimensions and applying the principle of homogeneity.

The old difficulty as to the use of the same word *pound* to denote both mass and force is partially overcome by writing lb. when mass is referred to, and pound when force is meant. There is thus a distinction to the eye if not to the ear. This convention, however, is not adhered to in the latter parts of the work.

In the development of the subject the reader is constantly reminded of the very useful fact that the various directed quantities which appear are vectors, and follow the vector law. But we think it would have tended to increased clearness of view if the author had brought into greater prominence the distinction between vectors the representative lines of which have different degrees of freedom, or, as they have been named, between unlocalised vectors, vectors localised in lines, and vectors which are localised at points.

The author's fundamental definition of a vector as a directed quantity merely, with the frequent inference that any quantity which has magnitude and direction is a vector and therefore obeys the vector laws, is open to criticism. The reader will find that its application to the resolution and composition of angular displacements on pp. 58 to 60 is not very clear or convincing. Stated in this form it is liable to lead to slips like the one we notice on p. 186:—

"If a rigid body has angular acceleration about an axis through its centre of mass, the resultant is a force couple in a plane at right angles to this axis. And conversely," &c.

In the chapter on central forces the author touches on planetary motions and on harmonic motion. The latter might with advantage be treated more fully in any subsequent edition, considered from the vector point of view, and with some reference to Fourier's theorem.

In treating of friction, only the simple approximate laws of solid friction are considered. Academic calculations are made as to the action and efficiencies of machines like the wheel and axle, the different systems of pulleys, the screw, &c. Some useful lessons, not revealed in the treatise under review, would be learnt by any student who had the opportunity of putting the results of these calculations to the test by actual experiments in a laboratory.

In the chapter on impact there are some practical observations on pile driving and on the limiting pressures which may be put on pile and earth foundations.

The section on the development of principles is brought to a close by a discussion of the action of the gyroscope and spinning top, and the statement of the equations of motion of a rigid body in their general form.

In the part dealing with the practical applications of principles, the subject-matter treats mainly of questions specially interesting to the civil engineer. This is naturally to be expected, having regard to the position and qualifications of the author.

There are two short chapters relating to framed structures and bending moments, evidently curtailed in anticipation of vol. ii. Then follows an interesting discussion on masonry structures, dealing with earth and water pressures, and including the design of masonry dams and retaining walls.

The closing section of the volume, comprising about 150 pages, relates to the "Statics of Elastic Solids," and deals with the design of such details as ties, riveted joints, pins and eye-bars, shafts, beams, springs and long columns; and the first volume concludes with an application of the principle of least work to the swing bridge, the metal arch, the stone arch and the suspension bridge.

The discussion of the theory of elasticity is meagre and disappointing. The various formulæ are established without giving the reader any clear insight with regard to the assumptions made and to the consequent limitations to the practical applications of the formulæ that are obtained. Consequently there is a tendency to interpret the results of the calculations as if they had the same certainty as demonstrations in geometry, and sometimes the proof given is quite illusory. For instance, the investigations on pp. 509 to 511 on the strengths of shafts need thorough revision. The work of St. Venant in regard to the torsion of shafts of other than circular section is entirely ignored. The formula $\frac{M}{I}=\frac{f}{r}$, applicable to circular shafts only, is taken as if it were true for all forms of section, and is actually applied to square and rectangular shafts. As another example of misleading theory, we think the working of example 3, p. 491, relating to a plate girder, should be entirely recast.

In other portions of the subject the author is more happy. He applies the method of strain energy and the principle of least work to framed metal arches, in a manner readily lending itself to cases of travelling loads. He also investigates temperature stresses in the two-hinged and the continuous arch. We think he is right

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in also applying the same methods and principles to stone arches and to stiffened suspension bridges, and that the results so obtained are probably more to be depended on than corresponding results by older writers based on other assumptions. However, in structures of this class, liable to be self-strained, and with important factors necessarily omitted or only roughly guessed at in any estimate of the straining actions, we should not be inclined to set the same value on the results of the calculations that the author seems to attach to them. The remarks made on p. 519, in reference to calculations for a four-leg table, probably apply largely to this case, and indicate the more appropriate attitude of mind in regard to the value to be assigned to the results.

Whilst pointing out that much of vol. i. will seem inadequate to an English engineer, we are glad to draw attention to the large number of practical examples scattered throughout its pages, and in many cases fully worked out. In fact, many students might refer to these with advantage, although they will have to look elsewhere for a more thorough discussion of the principles involved.

The second volume consists of the author's well-known treatise on "Stresses in Framed Structures," eleven editions of which have already appeared, the present revised edition being the first under the new title. Some of the subject-matter of vol. i. is repeated in vol. ii., so as to make the latter complete in itself.

Students and engineers on this side of the Atlantic who are interested in bridge building will wish to possess this volume, in which modern American practice is very fully dealt with. In developing the subject, the author gives numerous examples of the design and construction of details, worked out numerically and profusely illustrated by diagrams and drawings. Towards the end, the author quotes a standard specification for bridge work, in compliance with which he works out in detail a complete design of a typical structure, giving all the calculations, and accompanying the discussion by plates comprising a full set of working drawings.

The volume concludes wish special chapters by experts on shop drawings, office work and inspection; on the erection of bridges; and on lofty commercial buildings, in th construction of which steel enters largely.

SURFACE-FEEDING DUCKS.

The Natural History of the British Surface-feeding Ducks. By J. G. Millais, F.Z.S. Pp. xiv + 107. With 6 Photogravures, 41 Coloured Plates, and 25 other Illustrations. (London: Longmans, Green and Co., 1902.) Price 6 guineas net.

THE first feeling of a reader on closing Mr. Millais's "Natural History of the Surface-feeding Ducks" will be surprise that one individual—though naturalist, sportsman and artist in one, and blessed, as the author has been from boyhood, with exceptional opportunities—should have been able single-handed to collect direct from Nature so much new and interesting information about familiar birds.

The next will be, perhaps, a touch of regret that it should have been given to the public in a form and at a price (six guineas net) which must limit its readers to the favoured few who have broad bookshelves and substantial balances at their bankers, or who may be living within reach of rich libraries.

But the tyranny of custom has decreed that a monograph of bird or beast, if it is to take rank as a serious contribution to scientific literature, must dress up to the part, and appear in the form and type of a family Bible; and Mr. Millais, prudently no doubt, has judged it wise not to fly in the face of the conventionalities.

The result is a richly illustrated and beautifully got-up quarto volume weighing nearly nine pounds—about as much as a couple and a half of well-fed mallard—describing the life and changes of plumage of seven species of ducks more or less common in England, with pictures and shorter notices of three others which, as rare occasional visitors, have been admitted to the list of British birds. Mr. Millais has much that is interesting to tell of the courtships and varying habits of feeding of the ducks he writes about; of their contrivances for escaping the notice of birds of prey; and of their every-day life.

But it is to the wonderful plumage changes during the period of the drake's "eclipse," when at a time of helplessness he assumes the inconspicuous dress of his mate, that he has more especially devoted his attention. The conclusions he has arrived at add another to the marvels which every fresh discovery in natural history has revealed.

Birds, as everyone knows, periodically renew their feathers, some oftener than others; but all, or nearly all, probably at least once a year. As a rule—though often when undergoing the change they mope and show otherwise signs of the need of a tonic—the moult is effected without seriously incapacitating them. Geese and most kinds of ducks are an exception, and, at least in the case of the males, for a time commonly completely lose the power of flight. Why this should be so, science has never yet been able to suggest. But it is, incidentally, where the birds most congregate, of immense advantage to human beings. It is during the moult that the Samoyedes, without much more exertion than is involved in driving sheep into a pen, lay in their most important winter stores.

The most interesting chapters in Mr. Trevor Battye's "Icebound in Kolguev" are those in which he describes the great autumn goose drives in which he took part, when the birds, unapproachable at any other time, were knocked on the head by thousands to be salted down for future consumption.

Nature has been a little more pitiful to the ducks than to the geese, and for their protection has arranged that, during the week or two that the duck is practically flightless, he shall doff his conspicuous colouring, and masquerade in the unobtrusive dress of the female. In the case of the mallard, the colour even of the legs and beak is changed.

Nature in most of her processes works economically. In the matter of the drake's "eclipse" she is reckless. The strain put on the bird's system, for no other apparent reason than to avoid startling contrasts and produce the desired results gradually, is almost incredible.

Two-thirds of the mallard's feathers (viz. those of the head, neck, breast and parts of the back and scapulars),

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